Introducing White Pine into Poor-Site Hardwood Stands in West Virginia

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About the Author . . .

HARRY W. YAWNEY *was graduated from the Pennsylvania State University with Bachelor's and Master's degrees in forestry (1955 and 1957). Prior to this he had served with the U. S. Marine Corps in Korea. For a year he worked as a timber sales officer on the Deschutes National Forest in Oregon. In 1957 he joined the Northeastern Forest Experiment Station as a research forester on the Fernow Experimental Forest, Parsons, West Virginia. His assignments on the Fernow Forest have been mainly in forest management.*

A Common Problem

POOR hardwood land presents a problem that is only too well known: what to do with areas in hardwood country that support only stunted, slow-growing trees? This is a question that vexes foresters and landowners in many parts of West Virginia and neighboring mountainous areas of Maryland and Virginia. On these poor sites, it is doubtful whether the hardwoods can pay the taxes. Such stands usually are dominated by short-boled chestnut and scarlet oaks; and black gum, sourwood, white oak, and sassafras are the principal associates.

No accurate information is available as to how much forest land is on these poor sites. However, according to Forest Statistics for West Virginia (Wray 1952), 9 percent of the forest area of the state is occupied by the chestnut oak type, which is found on high, dry, rocky ridges. Most of this type would fall in the poor site category, and very likely some areas in other types would too. Though the question of how to make these sites productive is far from the most important challenge to foresters in this Appalachian area, yet it is of considerable importance.

White pine once occupied a more important economic and ecological place in the woodlands of West Virginia than it does today. Its decline followed the pattern typical of most sections of the Appalachians and elsewhere. From the beginning of settlement, white pine was a choice species of the timber cutters, and it was heavily "creamed out" of the stands. Later clearcutting, which occurred around the turn of the century, and the repeated fires that followed, eliminated all but a few of the pines.

Today, where a seed source is present, white pine is slowly reestablishing itself in some stands and perhaps in time could regain the importance it once held. On poor sites it might also replace the low-grade hardwoods, which took over the space once occupied by the blight-killed chestnut. The growth and form of scattered natural white pines show that it will produce a greater volume and better quality of timber on poor sites than the hardwoods. However, establishment of white pine on these poor sites through natural regeneration—even under the best of

conditions—would require many decades. Moreover, many such areas lack residual white pine seed trees or even potential ones.

Converting stands to softwoods appears to be the most promising approach to the problem. And since conversion by natural regeneration on most sites would be a very slow process, the feasibility of establishing the pine by artificial means is an important consideration.

In 1954 an exploratory study was started to determine on what sites white pine could be interplanted or underplanted into hardwood stands with reasonable success and at minimum expense. The objective is not complete conversion, but rather a mixed pine-hardwood forest where pine could be maintained indefinitely.

Oak site index was the criterion selected to define site quality. It is readily measured either by tree height and age in suitable stands (Schnur 1937), or by land features where suitable sample trees are not available (Trimble and Weitzman 1956).

The Study Area

Located on the Monongahela National Forest in Tucker County, West Virginia, the study area lies on a steep, southwest-facing slope of about 50 percent grade 9 chains long. Oak site indexes change rapidly—from 70 near the stream bottom to 40 at the ridge top.

The soil is a Gilpin silt loam derived from acid shale with interbedded sandstone. It is of medium texture, well drained and moderately permeable. Soil depth is variable: it averages 36 inches to bedrock on the lower plots, 30 inches on the middle plots, and 24 inches on the upper plots. The humus type is a thin duff-mull.

Precipitation for the area averages between 45 and 55 inches annually, of which 6 to 8 inches falls as snow.

The natural forest stand on the area was composed of low-grade hardwoods, primarily in pole sizes 40 to 50 years old (fig. 1). Scattered members of an older stand, 65 to 90 years of age and of small sawtimber size, also were present. Scarlet, white, and chestnut oaks predominated on the middle and upper

Figure 1. — Condition of the stand on the middle plot before planting of seedling pines. These trees are oaks, mostly scarlet, white, and chestnut oak, 40 to 50 years old.

plots; beech and mixed oaks, with scattered black birch, yellow-poplar, and blackgum on the lower plots.

Ground cover was light on all plots. Greenbriar, wintergreen, and rhododendron were the principal species on the lower plot. Higher on the slope, blueberry and mountain laurel were the major species. Hardwood reproduction was sparse.

Methods

Six 0.3-acre plots, arranged in pairs, were laid out on the study slope. Thus there was one pair at each of three slope positions—lower, middle, and upper. Plots were separated by ½-chain or wider isolated strips. Site indexes, based on Schnur's oak site index curves, were 59, 52, and 45, respectively, for lower, middle, and upper pairs of plots.

About 160 white pine seedlings (age 3-0) were hand-planted on each plot in the spring of 1954. Spacing approximated 9 x 9 feet, but uniform spacing was not sought; seedlings were planted in the most advantageous spots to reduce the effect of competition from existing cover.

One treatment was applied initially: on one plot at each slope position the overstory trees about 4 inches d.b.h. and larger were girdled; on the companion plot the overstory was left undisturbed. In terms of crown removal, the girdling about equalled a clear-cutting for small products. Late in 1957—four growing seasons after planting—a second release was made on half of each previously treated plot. Not all brush and hardwood growth was removed, but only that competing vegetation growing in immediate proximity of each pine was cut back.

Results

Survival and height data were recorded at the end of the growing seasons—1954, 1956, 1957, and 1959 (table 1).

Survival

Survival on all plots has been exceptionally good, ranging from 89 to 99 percent. None of the differences in survival among treatments or slope positions was statistically significant.

But the bare figures do not tell the whole story. Most of the seedlings on plots that were not released are sparsely needled, light-colored, and spindly, have crooked leaders, and generally lack vigor. With a few exceptions, seedlings on released plots

Table 1.--*Mean height growth and percent survival of white pine seedlings planted (spring 1954) under two conditions on three slope positions*[1]

Plot	Site index	Mean height, in feet				Survival in percent			
		1954	1956	1957	1959	1954	1956	1957	1959
				OVERSTORY NOT REMOVED					
Lower	59	1.26	1.71	2.09	2.48	99.4	98.8	96.3	94.4
Middle	52	1.27	1.84	2.19	2.75	98.2	96.4	94.1	93.5
Upper	45	1.05	1.50	1.92	2.60	99.4	99.4	96.1	91.2
				OVERSTORY REMOVED[2]					
Lower	59	1.30	2.52	3.37	5.25	100.0	97.4	94.2	89.0
Middle	52	1.09	2.52	3.53	5.79	100.0	100.0	98.4	98.4
Upper	45	1.18	2.76	3.86	6.53	100.0	100.0	100.0	98.7

[1]All growth and survival records taken in the fall of the year.

[2]Based on data from all plots where the overstory was initially removed, including those split plots that were treated to a second release in the fall of 1957.

are heavily needled, of good color, and straight-stemmed. The indications are that mortality on the unreleased plots will increase in the future.

Growth

Height growth has been markedly affected by both release treatment and site.

Effect of Treatment

By the end of the second growing season, differences in height growth due to treatment were apparent. After the third season, seedlings on released plots averaged about a foot taller, and after the sixth season they averaged more than twice as tall as those on the unreleased plots—5.82 vs. 2.62 feet. Differences were significant at the 1-percent level.

After 2 years, there has not been much additional response by the pines to the second release. A slight growth acceleration occurred on the mid-slope plot, but on the other two plots the response was scarcely perceptible. As will be noted later, many of the pines that received the second release still were in a better competitive position after 2 years than those that had only been released from the overstory. So it is quite possible that the pines yet may respond favorably to the second release.

Effects of Site

Height growth was inversely related to site index. This showed up best on the released plots, where the masking effects of overstory competition had been eliminated. Still, the same trend was evident on a smaller scale on the untreated plots. On the released plots, height increments in the 5 years since the first growing season (1954) averaged 3.95, 4.70, and 5.35 feet, respectively, for site indexes 59, 52, and 45, as represented by the lower, middle, and upper slope plots.

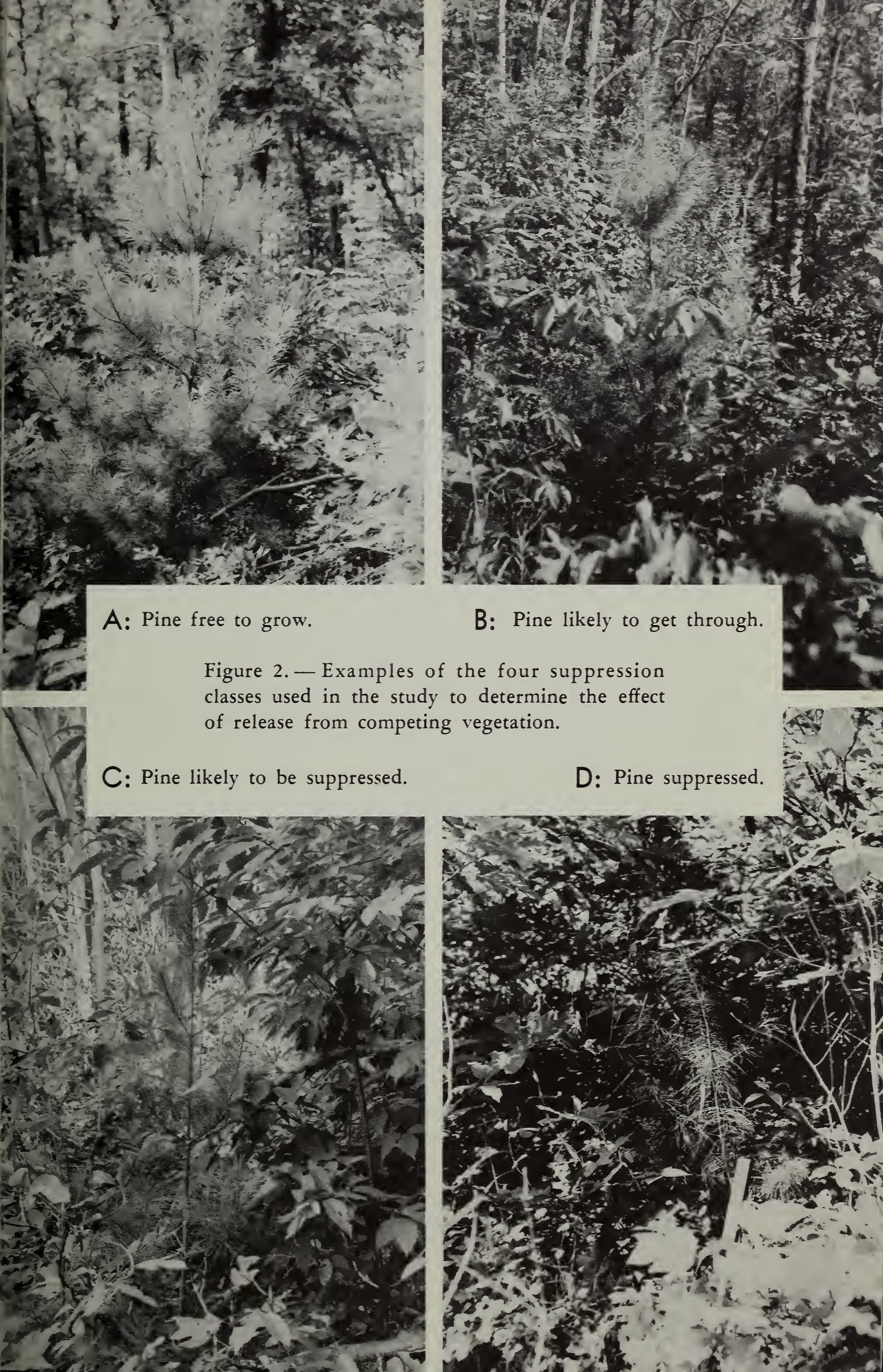
In contrast to our observations, Sander (1956) in a study made in Kentucky found the growth of planted white pines to vary directly with site quality on a slope. His conditions differed from ours, however, in that his plantings were given several complete releases during the 5-year period of record.

Sander's results belie any suspicion that white pine is inherently better adapted to poor sites than good ones. Since his trees were maintained free of top competition, whereas ours were not, it seems obvious that the inverse relationship with site in our plantings developed because the hardwood sprout and shrub competition was most intense on the best (lower slope) site and least on the poorest (upper slope) site. That is, the effect of this competition more than offset the effect of site quality upon growth of the planted pines.

Effect of Site and Release

Seedlings on each released subplot (including subplots released only once and those released again in 1957) were classified into four suppression categories based on relative freedom from other vegetation in competition for sunlight (fig. 2 and table 2). The results of this classification might be considered a probability-of-success rating.

The effects of site quality and of the second release were well revealed by this classification. For the lower, middle, and upper slope positions respectively, 12, 21, and 37 percent of the pines on the once-released subplots were either completely free, or had at least the top third of their height above the surrounding



A: Pine free to grow.

B: Pine likely to get through.

Figure 2. — Examples of the four suppression classes used in the study to determine the effect of release from competing vegetation.

C: Pine likely to be suppressed.

D: Pine suppressed.

Table 2.--*Percentage of seedlings in each suppression class*[1] *6 years after planting*

Plot (slope position)	Site index	Treatment and suppression rating							
		One release				Two releases[2]			
		A	B	C	D	A	B	C	D
Lower	59	2	10	58	30	27	15	44	14
Middle	52	0	21	48	31	24	36	35	5
Upper	45	8	29	46	17	32	42	19	7

[1]Suppression ratings defined: Class A--Pine free to grow; trees growing in full sunlight. Class B--Pine likely to get through; trees receiving less than full sunlight, at least top third above surrounding vegetation. Class C--Pine likely to become suppressed; trees receiving moderate sunlight, pine may be overtopped by surrounding vegetation but not completely closed in; may receive light from one or more sides. Class D--Pine suppressed; trees receiving no direct sunlight, completely overtopped and closed in by surrounding vegetation.

[2]Second release made 4 years after planting.

vegetation; on the twice-released subplots, the comparable figures were 42, 60, and 74 percent. So, the poorer the site, the higher was the percentage of pines in sufficiently favorable positions so that they should come through competitively without further help. Here again, as with height growth, there was a definite inverse relationship with site quality.

The value of the second release in accelerating height growth was evident only on the middle plot. Lack of height growth response on the lower plot probably was due to the rapid resurgence of sprouts and shrubs, which again became dominant in the growing season after cutting. The upper plot did not respond to the second release as well as the middle plot, possibly because release here was less needed.

The data in table 2 are indicative of the relative rate of sprout and shrub regrowth after cutting. In the spring of 1958 before growth started, *all* pines treated to the second release were free of competing vegetation. Two years later 58 percent of the freed trees on the lower plot, 40 percent of the middle plot, and 28 percent of the upper plot again were in suppression classes C or D. That is, they were either overgrown or in danger of being overgrown. On the lower plot, regrowth was so vigorous that the second release scarcely was perceptible after 1 year.

Discussion and Conclusions

The 6-year results of this study are in accord with Minckler's (1953) findings in southern Illinois: that on fair to good sites pine should not be planted in competition with native hardwoods, but that on poor sites planted pine has a good chance of keeping ahead of hardwood reproduction. They agree also with Trenk's (1955) observations in Wisconsin that financial and silvicultural success in converting hardwoods to white pine can be achieved only on poor sites.

Keeping in mind the objectives of this study; that is, to define sites where poor hardwood stands can be converted to mixed white pine-hardwood stands without the need for intensive release work, certain tentative conclusions can be drawn from the 6-year results:

- On forest land of site index 40 to 50 for oak, white pine can be planted with reasonable success after a heavy cutting of all merchantable hardwoods. Trees not harvested should be killed by girdling or poisoning. The hardwoods should be cut in the late summer, fall, or winter to reduce the incidence of sprouting and to delay sprout growth until after the pine has been planted. In the spring, 150 to 200 or more white pine seedlings per acre (2 to 4 years old) should be planted in the more open spots. A mixed white pine-hardwood stand should result, with a fair number of the planted pines represented in the dominant canopy.

- From 3 to 5 years later, a release from hardwood sprouts will, in most instances, increase survival and growth of the pine. However a fair proportion of the pines should come through without release. The older the stand of hardwoods when cut, the less the sprout competition that appears after cutting, and the less will be the need for an after-planting release of the pine.

- If there is little or no release, the upper marginal site for the introduction of white pine into hardwood stands appears to

be between site indexes 50 and 60. This study did not include the more intensive types of release treatments. However, it may be pointed out that, by proper use of herbicides, the marginal site index probably could be somewhat higher or, in effect, that the hardwood competition could be controlled by a reasonable effort and the pines could be brought through on sites of 60 and better.

Information about species conversion on sites below site index 40 for oak is not available from this study. It is quite possible that such sites are not good enough for white pine, and that conversion should be based upon less-demanding species, such as Virginia pine. More research is needed on these extremely poor sites.

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